THE TWIST OF WOOD-FIBER IN THE TAMRAC PINE

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During my college days in Ohio I once heard a back-woodsman holding forth on the "twist" of the grain of the "Northfield Oak" of Summit County. Its fibers, he affirmed, "always went round and round the trunk with the sun," and he was sure that the sun's daily movement across the sky caused the twist and determined its direction. I doubted the assertion that the twist in this species was invariably a left-hand twist, but I was perfectly sure that the sun's movement did *not* determine its direction. If it did, then all exogenous trees in our north temperate zone should have the same twist—which notoriously they do not. The questions thus started made a deep impression upon me, especially when I found out later that our masters in botany had no answers to them—and so far as I can learn they still have none.

A summer vacation in the eighties, spent in the neighborhood of a lumber-camp, showed me that my doubt as to the constancy of direction of the twist in any given species of tree was well founded. Both right-hand and left-hand twist occurred in every sort of timber cut there. In any given species, one direction was generally more common than the other, but it did not then occur to me to ascertain the ratios more definitely.

Three years ago, however, as I came down the Tioga road from the Meadows, there were stretches of forest where hundreds of tamrac pines *(Pinus contorta* var. *murrayana)* had been killed by the borers, and were standing by the roadside stripped of their bark as if awaiting physical examination. I at once recognized my opportunity and, pencil in hand, tallied the twist of some two hundred and fifty of them. Eighty per cent showed the right-hand twist. A few days later, in the remote and isolated Jack Main cañon, I made a similar tally which showed about seventy per cent of the left-hand twist. These observations seem to indicate that the direction of twist is a heritable quality, fairly well maintained along definite lines of descent, though somewhat interfered with by variation or by mingling with the opposite strain.

In the interval between these observations I had spent a day in camp at Porcupine Flat. There I looked up the leaf-arrangement of the tamrac pine, and worked out the direction of its fundamental leaf-spiral in a considerable number of trees about camp. I found here again the same variation between right and left-hand spirals that I had noted in observation of the twist of wood-fiber, and with a like preponderance of the one over the other.

This suggested, of course, a real connection of some sort between the two phenomena. If at the time I had recognized the full significance of the suggestion, I should at once have put the matter to the

test of crucial experiment. I should have ascertained the direction both of leaf-spiral and of fiber-twist in the *same* trees, stripping off the bark to make sure of the latter. If in a sufficient number of cases the two should be found to be either uniformly coincident or uniformly reversed, we should infer some causal relation, direct or indirect, between the two phenomena. On the other hand, if coincidence and opposition were found to be not uniform, we should infer either that these two phenomena are either wholly unrelated, or that some other cause or causes interfere to modify or obscure whatever relation might exist between them. My opportunity for making this experiment was thus lost; but I trust that some one else may find the problem sufficiently interesting to carry it through—and to report the results.

Meantime it may be well to examine a little into the nature of the leaf-arrangement of this pine, and consider what possibilities it affords for a causal relation between it and the twist of wood-fiber. The accompanying diagram (Fig. 28) is an enlarged representation

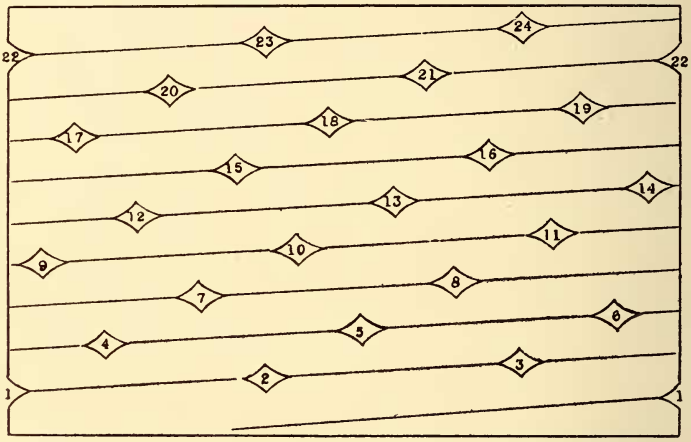

Fig. 28. Diagram of the Leaf-Arrangement of the Tamrac Pine

of the surface of a short section of the terminal shoot of a young tamrac pine in early spring, before it has attained its full length and has consolidated its wood-fiber. The outer layer has been cut open along a vertical line—which appears here at both the right-hand and the left-hand margins of the figure—has been stripped off and spread out flat. The numbered points are the positions of the leaf-clusters. The primary, or fundamental, leaf-spiral is the line which passes through all these points in order. It appears in the diagram as a series of transverse lines rising at a low angle toward the right. If the margins of the figure were rolled backward so as to meet again as they do on the stem, these lines would form the continuous spiral just described. Along this spiral the leaf-stations are

spaced equally at an interval such that only after making eight complete turns around the stem, and passing twenty-one stations, do we come to a station, No. 22, which stands directly above No. 1 and begins a second cycle exactly like the first. This particular arrangement is therefore called a right-hand $\frac{8}{21}$ arrangement. The corresponding left-hand arrangement would be exactly the same, save that right and left would everywhere change places, as they would were we to look at the reflection of this diagram in a mirror.

Now the general facts regarding the growth of wood-fiber are well understood, and may be summarized as follows:—The leaves develop one after another in ascending order according to their positions on the fundamental spiral. From the base of each, at a certain stage of development, bundles of wood-fibers begin to form, and these extend downward along the axis, interlacing with similar bundles from other leaves, till finally they form together a continuous shell of wood just within the layer of bark. Presumably the growth might be *directly* downward were there no obstacles in the way. But obstacles there are, as a glance at the diagram will show. Every leaf-base is such an obstacle standing more or less in the way of growth from above. For, if we choose as a starting point one of the upper leaf-bases in the diagram—say No. 23—we see that the space below it is free no farther than to No. 15. The left-hand margin of the bundle of wood-fibers from No. 23 is sure to encounter the right shoulder of No. 15, where doubtless some of its fibers will lose themselves in effecting the junction; and from this point on the bundle from No. 15, already established, forms a fixed barrier to any further spread of the bundle from No. 23 in that direction. But the fibers from No. 23 are still in process of formation, and are free to develop along the line of least resistance. The growth from No. 23 therefore we may think of as crowded over to the right until its edge touches the edge of the bundle from No. 18. Confined then between these two barriers, its general direction may be taken to be the line between No. 23 and No. 10—at which latter point its separate identity may be considered as coming to an end.

But what happens in the case of No. 23 is repeated in the case of every other station in the whole scheme. The exact repetition of the quincuncial pattern gives to every station in the diagram the very same position with regard to its neighbors, the same fixed obstacles, and the same open fairway. The whole sheet of wood-fiber, made up of the bundles from each leaf-base, must have the same inclination that they all have separately. Though the actual growth from each station is downward, yet since the development as a whole is upward, we shall avoid confusion by naming the direction of the slant here shown as if its lines really grew upward. We call it therefore a left-hand twist.

The hypothesis here is that a definite pattern of leaf-arrangement may cause a definite deflection in the line of growth of wood-

fibers by the series of physical obstacles which it places in their pathway. If the hypothesis be true, and be correctly applied to the conditions actually present in the tamrac pine, a right-hand leaf-spiral, as shown in the diagram, should give a left-hand fiber-twist; and conversely, a left-hand leaf-spiral should give a right-hand fiber-twist. This discussion therefore adds a second question for the prospective explorer in this field, namely: Are these hypothetical results borne out by the results of actual observation? An affirmative answer here, following an affirmative answer to the first question, would be an important step toward confirming the theory here suggested.

If the line of experiment here suggested does not at once consign this theory to the limbo where all its predecessors have gone, there is still left an enormous field of investigation to be covered before what may be established for this particular tree or for this particular leaf-pattern can be applied to exogenous tree-growth in general.[1] Science, as well Art, is long indeed—and Life alas is short for either!

FIELD NOTES ON ERICACEAE OF THE TAHOE REGION

Viola B. Baird

The field covered by these notes I have explored quite thoroughly during five consecutive summers. It includes both banks of the Truckee River from Lake Tahoe to Bear Creek, the valleys of Bear Creek and Squaw Creek, with the uplands between the sources of these two streams and Five Lakes Creek. The altitude ranges between 6100 feet at the mouth of Squaw Creek to 7540 feet at the Five Lakes. Within this area is a great variety of situations and conditions: alpine meadows, swamps, barren cliffs, and forests of fir and pine. It is hoped that these notes may prove to be some slight contribution to the general knowledge of these interesting and lovely plants.

1. *Pyrola asarifolia.* In colonies, where a streamlet flows through a growth of willows or alders. It has a large round basal leaf, and flowers which in odor and appearance resemble those of the lily-of-the-valley, save that the corolla is tipped with rose. In bloom from middle to late July. Found on both sides of the Truckee River from the Lake to Deer Park station.

[1] Since the above was placed in the editor's hands, my attention has been called to a note in the *American Breeder's Magazine,* vol. 1, p. 262, to the effect that experiments with seedlings of *Pinus ponderosa* show "a decided twist of fibers from the time of germination," that is, before there could be any physical obstacles to determine its direction. And I also had recalled the remarkable cabling of the great roots of *Sequoia gigantea,* where the same thing would be true.